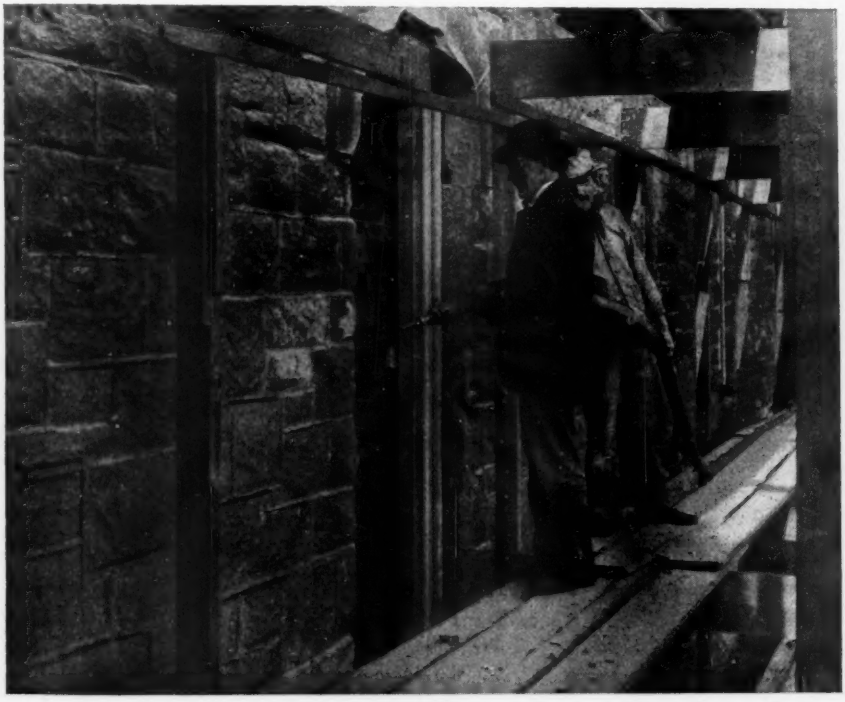
GENERAL LIBRARY,
UNIV. OF MICH.
5 AUG 1898

Compressed Air

DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. III. NEW YORK, AUGUST, 1898. No 6



THE SAND BLAST PROCESS AS APPLIED TO THE CLEANING OF THE WALLS OF PARDEE HALL, LAFAYETTE COLLEGE

LIDGERWOOD M'F'G CO.,

Boston.
Philadelphia.
Cleveland, O.

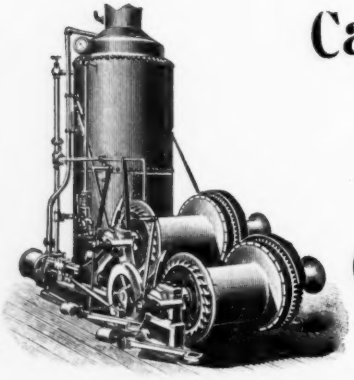
96 Liberty Street,
New York.

Chicago.
Portland, Ore.
New Orleans.

STANDARD

High . . .
Speed
Hoisting Engines,

Built on the Duplicate Part System.



Cableways,
Hoisting
and
Conveying
Devices,

For Canal and Trench Excavating, Dam Construction, Wall and Pier Building, Mining, Quarrying, Logging, and General Contract Work.

Fiske Brothers Refining Co.

NON-CARBONIZING OIL

FOR USE IN AIR CYLINDERS OF

AIR COMPRESSORS

Also All Grades of Lubricants for Use on Machinery

Propelled by Compressed Air

OFFICE AND SALESROOM, 59 WATER STREET,

CABLE ADDRESS, "LUBROLEINE."

NEW YORK, U. S. A.

McNAB & HARLIN M'F'G CO.,

MANUFACTURERS OF

BRASS COCKS,

PLUMBERS' BRASS WORK,

Globe Valves, Gauge Cocks, Steam Whistles and Water Gauges,

WROUGHT IRON PIPE AND FITTINGS,

Plumbers' and Gas Fitters' Tools,

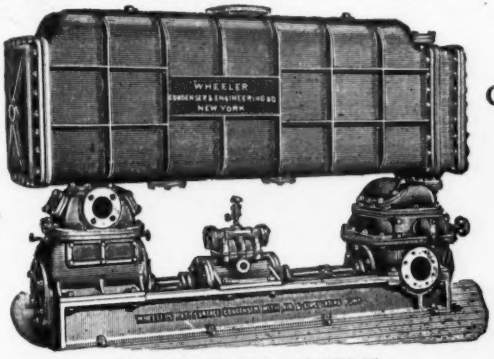
No. 56 JOHN STREET, - - NEW YORK.

Factory, Paterson, N. J.

Wheeler Condenser & Engineering Co.

120 & 122 LIBERTY STREET NEW YORK.

For MARINE and STATIONARY SERVICE.

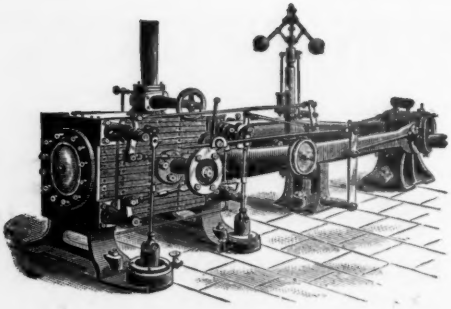


SURFACE CONDENSERS Mounted on Combined Air and Circulating Pumps.

PROPRIETORS AND MANUFACTURERS OF

WHEELER STANDARD SURFACE CONDENSER; WHEELER ADMIRALTY SURFACE CONDENSER; WHEELER LIGHTHALL SURFACE CONDENSER; VOLZ PATENT SURFACE CONDENSER AND FEED WATER HEATER; EDMISTON PATENT FEED WATER FILTER.

WHEELER'S PATENT FEED WATER HEATER.



Established
1833.

The

C. & G. COOPER CO.

MT. VERNON, OHIO.

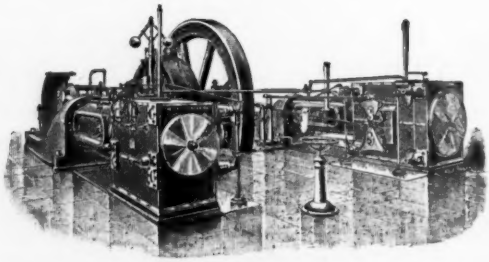
CORLISS ENGINES.

COMPOUND.

TRIPLE EXPANSION.

SINGLE CYLINDER.

Of all sizes up to 3,000 Horse-power.



— FOR —

FACTORIES, RAILWAYS, ELECTRIC LIGHTING, ROLLING MILLS, AND ALL KINDS OF MANUFACTURING.

CORRESPONDENCE SOLICITED.

HOME OFFICE: MT. VERNON, OHIO.

NEW YORK: Room 1022 Havemeyer Building, F. W. IREDELL, Mgr.

G. WILFRED PEARCE,
Electrical, Steam and Compressed Air Apparatus,
ST. PAUL BUILDING, NEW YORK.

Used by the Officers of all Railroads
(ISSUED QUARTERLY) THE POCKET LIST OF RAILROAD OFFICIALS
Subscription Price, $1.00 per annum. Advertising rates on application.
THE OFFICIAL RAILWAY EQUIPMENT REGISTER (ISSUED MONTHLY) Descriptive of freight and passenger cars of the Railways and Private Companies in the United States, Canada and Mexico.
Subscription Price, $5.00 per annum. Single copies, $1.00.
THE RAILWAY EQUIPMENT & PUBLICATION CO.
24 Park Place, New York.

Trimo Giant Pipe Wrench

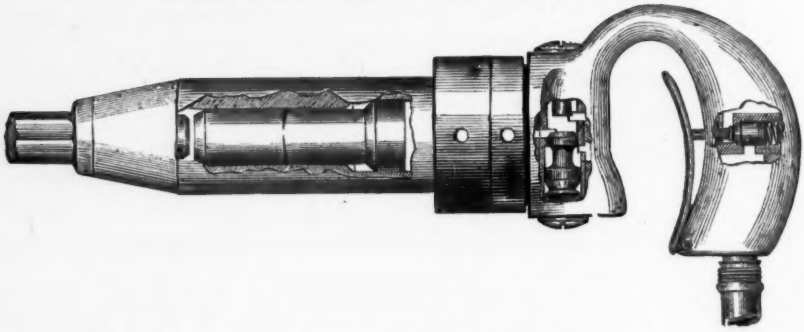
The strongest, safest and most durable Pipe Wrench in the world. Made and adapted for all kinds of work as well as hard or rough usage. Send for catalogue of Trimo tools.

TRIMONT MANUF'G CO., Roxbury, Mass.
FOR SALE BY ALL JOBBERS.

No. O.
PNEUMATIC
BREAST DRILL.
Weight, 10½ Lbs. Capacity to ½ In.
Simple, Durable, Efficient.
Empire Engine & Motor Co.,
ORANGEBURG, N. Y.
MACHINES SENT ON TEN DAYS TRIAL.

United States Metallic Packing Co.,

PHILADELPHIA, PA.



Manufacturers of the most economical Air Tools in the market, such as

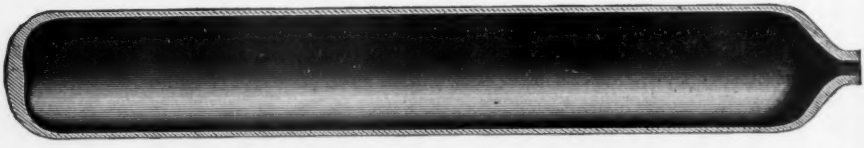
PNEUMATIC HAMMERS,
" DRILLS,
" TRACK SANDERS,
" BELL RINGERS.

METALLIC PACKING FOR ALL KINDS OF SERVICE.

CHICAGO OFFICE: 003 MARQUETTE BUILDING.

OFFICE AND WORKS: 427 NORTH 13th STREET

MANNESMANN TUBE WORKS,



MANUFACTURERS OF

Seamless Rolled Tubes for Gasss, Compressed Air, Etc.,

UNDER HIGH PRESSURE.

Tested and approved by the highest authorities and Governments of Europe and America.

Each Tube is carefully tested, and a Government Test Certificate is furnished with each Tube. Representatives:—

CHAS. G. ECKSTEIN & CO.,

249 CENTRE STREET, - - NEW YORK.

J. D. MILLER & CO.,

TAYLOR BUILDING 39 & 41 CORTLANDT ST., N. Y.

COMPLETE POWER PLANTS,

FOR ALL PURPOSES

ENGINES, BOILERS, MACHIRERY,

MINING AND MILLING EQUIPMENTS.

Send for Catalogues and Estimates on what you need.

The FOSTER

New "Class W" (Automatic) Pressure Regulator.

The only Pressure Regulator satisfactorily controlling High Initial Air Pressures.

In successful service on ALL the AIR-MOTORS yet tested.

FOSTER ENGINEERING CO.,

NEWARK, N. J.

PNEUMATIC APPLIANCES.

DRILLS, REAMERS, TAPPERS,
RIVETERS, CAULKERS, CHIPPERS,
HOISTS, MOTORS, COMPRESSORS,
STAY BOLT CUTTERS, SAND SIFTERS, ETC.

SEND FOR NEW CATALOGUE JUST ISSUED.

C. H. HAESELER CO.,

1026-1030 HAMILTON STREET, - - PHILADELPHIA, PA.

THE PELTON WATER WHEEL

Embracing in it variations of construction and application

THE PELTON SYSTEM OF POWER.

In simplicity of construction, absence of wearing parts, high efficiency and facility of adaptation to varying conditions of service, the **PELTON** meets more fully all requirements than any other wheel on the market. Propositions given for the development of water powers based upon direct application, or **Electric Transmission** under any head and any requirement as to capacity.

Compressed Air Transmission.

No other wheel is so well adapted to this purpose. Where the head admits, it can be attached to compressor shaft direct, and serve for prime mover and fly wheel as well.

Correspondence Invited. Catalogues Furnished upon Application. Address,

PELTON WATER WHEEL CO.,

121-123 MAIN STREET, SAN FRANCISCO, CAL.

143 LIBERTY STREET, NEW YORK.

BOSTON. NEW YORK. PITTSBURG. CHICAGO. ST. LOUIS.

National Tube Works Company,

MANUFACTURERS OF

Standard Steam, Gas and Water Pipe.
Locomotive and Stationary Boiler Tubes.
Special Flanged Pipe for Compressed Air.
Pump Columns for Mines.
Special Light Lap-Welded Pipe, fitted with the Converse Patent Lock Joint for Water and Gas Mains.
Cylinders with Dished or Flat Heads for Carbonic Acid and other Gases.

NEW YORK OFFICE: HAVEMEYER BUILDING.

An Important Connecting Link in Compressed Air Service.

The Moran Flexible Joint

For high pressure, indispensible.

Tightness, safety, flexibility and durability assured.

Parties making experiments with Compressed Air may have the use of the "Moran Joint," free for a limited time.

MORAN FLEXIBLE STEAM JOINT CO.,

LOUISVILLE, - - - - - KENTUCKY.

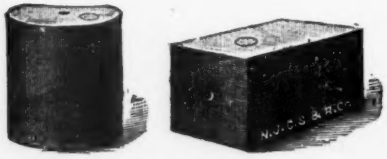
ESTABLISHED 1858.

"Our Name and Brand a Guarantee of Quality."

High Grade Rubber Goods.

CHANNELING SPRINGS.

BELTING.
TUBING.
VALVES.
HOSE
TUBING.



SPRINGS.
MATS.
MATTINGS.
GASKETS.
PLAY PIPES.

LINEN AND COTTON HOSE.

NEW JERSEY CAR SPRING & RUBBER COMPANY,

MAIN OFFICE AND WORKS:

Wayne and Brunswick Streets, Jersey City, N. J.

BRANCH OFFICE: 10 BARCLAY ST., NEW YORK.

Compressed Air.

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

W. L. SAUNDERS, - - Editor and Proprietor
A. E. KENNEY, - - Managing Editor
J. E. QUINTERO, - - - - Treasurer

Subscription, including postage, United States, Canada and Mexico $1.00 a year. All other countries, $1.50 a year. Single copies, 10 cents.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

All communications should be addressed to COMPRESSED AIR, 26 Cortlandt St., New York. London Office, 92 & 93 Fleet Street.

Those who fail to receive papers promptly will please notify us at once.

Entered as Second-Class Matter at the New York, N. Y., Post Office.

VOL. III. AUGUST, 1898. NO. 6.

"COMPRESSED AIR,"

SIRS:—

The table for per cent. of work lost due to heat of compression, in the July number, may be criticised by your readers for stating the per cent. of loss in some cases greater than 100%.

It appears from results that the work lost is stated in terms of *isothermal* compression, but since it is more practical to state the loss in per cent. of *adiabatic* compression, I suggest reference be made to table in Vol. I., No. 4.

I think that I am responsible for both tables given, and consider the table in Vol. I. the more intelligent of the two; and make this suggestion so that the man who thinks he has found a big mistake, i. e., in having a loss greater than the actual work done, can use the other formula.

Yours truly, F. C. WEBER.

New York, July 22, '98.

The table published in our July number is correct, but that it may not be misunderstood we have asked Mr. Weber to further illustrate this important point in air compression.

When air is compressed in one stage to a pressure of 2,000 pounds per square inch, more power (theoretically) may be consumed in overcoming resistance due to the heat of compression, than is required to compress the air isothermally hence the importance of stage compression and intercooling when dealing with high pressures. This point is clearly brought out by Mr. Weber in the following interesting figures. —ED.

DELIVERED HORSE POWER PER 100 CU. FT. FREE AIR COMPRESSED FROM ATMOSPH. TO GAUGE PRESSURE.

Gauge Pressure lbs. per □"	One Stage Compression adiabatic.	Isothermal Compression.	Difference between Adiabatic and Isothermal.	% of work lost in terms of Isothermal Compsion.	% of work lost in terms of Adiabatic Compsion.
				A	B
60	13.41	10.32	3.09	30. %	23. %
80	15.92	11.90	4.02	34.	25.26
100	18.10	13.15	4.95	38.	27.58
200	26.20	17.20	9.00	52.35	34.40
400	36.	21.35	14.65	68.60	40.75
600	43.20	23.90	19.30	83.75	44.66
800	48.80	25.70	23.10	90.	47.40
1000	53.59	27.20	26.39	96.80	49.20
1200	58.50	28.35	30.15	106.15	51.60
1400	61.20	29.40	31.80	108.	52.
1600	64.30	30.10	34.20	110.	53.3
1800	66.80	30.80	36.00	116.80	54.
2000	69.80	31.50	38.30	121.70	54.8

Interpretation of tables "A" and "B."

Neglect all friction losses.

Consider the case of compressing 100 cu. ft. free air to 2000 lbs. gauge pressure.

To do this work in a one stage compressor will require 69.8 H. P.

Of this 69.8 H. P. 38.3 H. P. which is due to the heat of compression, will be lost (usually) due to radiation, before the air reaches the motor.

Table "A" expresses this loss in per cent. of the power available at the motor, which in this case is 1.216 times the available power, or it is 121.6% of the isothermal Horse Power of compression.

Table "B" expresses this loss in per cent. of the power actually put into the compressor, and in this case represents 54.8% of that power or the adiabatic Horse Power of compression.

As we are dealing with the "compressor end" in this article, it will be more pertinent to express the loss in terms of adiabatic compression which is done in table B.

The Sand Blast Process as Applied to the Cleaning of the Walls of Pardee Hall, Lafayette College.

After the walls of Pardee Hall, Lafayette College, left standing from the fire, had been inspected and pronounced safe for rebuilding, the problem arose as to how the smoke stains on them could be removed.

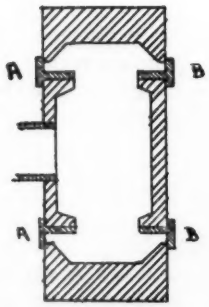
Various plans suggested themselves as to the cheapest and most effective manner of accomplishing this, but to the recommendation of Mr. W. S. Ayer, C. E., '72, was due the final adoption of the sand blast. The application of the sand blast to glass cutting and to cleaning castings is very common, but it had never been applied to the cleaning of stone walls and its usefulness for this purpose was largely a matter of conjecture.

The Wall before Cleaning.

The air compressor and receiver for the operation were loaned to the college by the Ingersoll-Sergeant Drill Co., from their works at Easton, Pa.

The compressor was supplied with steam from a 10 h.p. vertical boiler belonging to the college at a maximum pressure of 50 lbs. The compressor was one of the company's direct acting type having a 10" x 10" steam cylinder and a 10" x 14½" air cylinder. The cylinders are directly in line, the piston rods being connected to a common crosshead. To each side of the crosshead are attached connecting rods which drive a pair of fly-wheels rotating on a shaft immediately in front of the steam cylinder. On the same shaft are placed two eccentrics for actuating the Meyer's expansion valve in the steam chest.

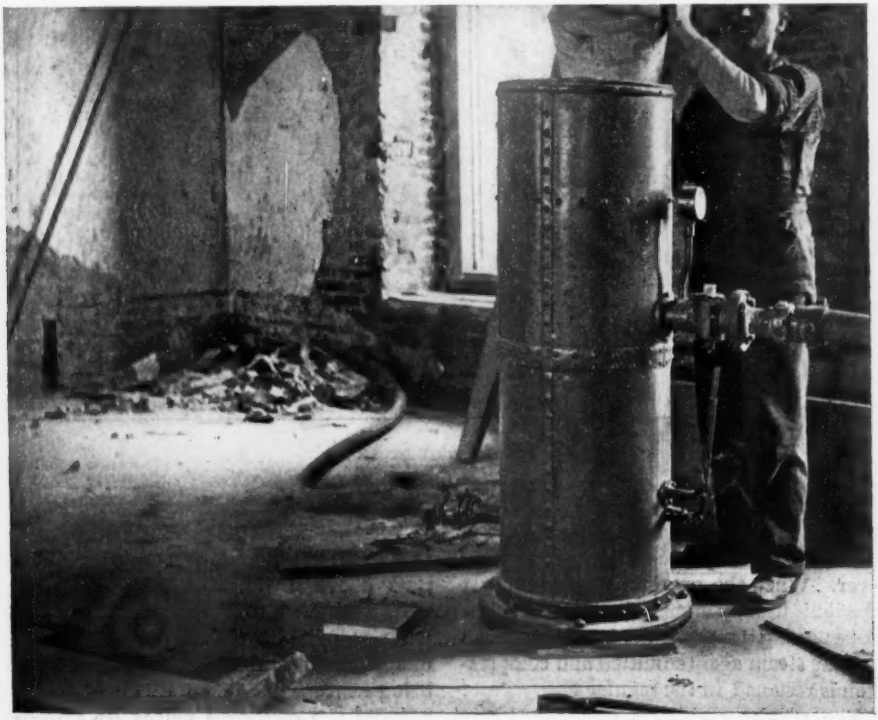
Air is supplied to the air cylinder through a pipe running through a stuffing-box in the rear end of the air cylinder. This pipe leads to an air chamber in the piston from which air is alternately allowed to pass into opposite ends of the cylinder.



This is accomplished by means of a pair of valve rings on the piston. The action of these rings is shown by the sketch.

A and B represent the rings on each end of the piston in section. When the piston moves to the right B is in and A out, compressing the air to the right of the piston and admitting it to the left. When the piston reaches the end of its stroke and stops, the momentum of the valve rings throws B open and shuts A. On the return stroke the air pressure holds them in these positions and the operations are reversed. Holes are cut in the webs of the rings through which pins are run, limiting the motion of the rings to about ¼" in this machine.

The advantage claimed for these valves over the spring valves in ordinary use is that they remain open during the full length of the stroke, enabling the compressor to get a full cylinder of air at th atmospheric pressure ; while the spring valves, requiring a difference of pressure



Ward and Nash Sand Blast. Putting sand in the machine.

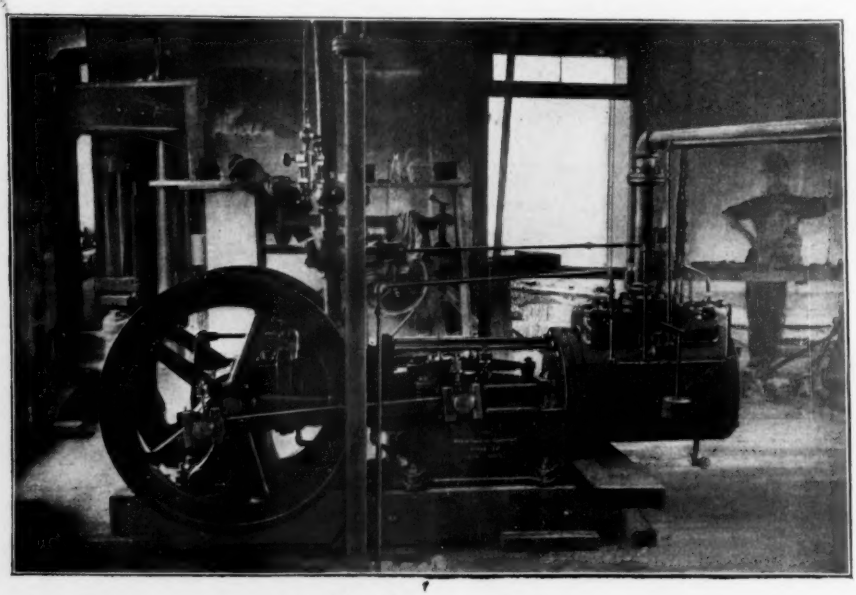
between the outside air and the interior of the cylinder to keep them open, supply air at less than the atmospheric pressure and are apt to close before the end of the stroke, when the piston is running slowly and the influx of air very small.

The air is discharged through special check valves placed at the ends of the cylinder whose action will be explained later.

The compressor is furnished with a regulator to take the load off the air piston when the pressure in the receiver reaches a given point, and at the same instant, to throttle the supply of steam to a point just sufficient to keep the compressor turning over. When the pressure goes down past the limit usually eight or ten pounds below the running pressure, the load is thrown on, the steam again admitted and compression is resumed in the regular way.

The regulator which accomplishes this consists essentially of a weighted piston (the cylinder in which it acts being connected to the receiver) connected to a small slide valve. From the regulator, pipes are run to the discharge valves at each end of the air cylinder and to a throttle valve in the steam pipe.

Normally the weighted piston is down and the pipes leading from the regulator to the discharge valves and to the throttle valve are filled with air at receiver pressure. The result is that the air pressure back of the discharge valves causes them to act as check valves, letting air out but not into the cylinder, and the throttle valve is held open giving full steam pressure to the engine. When the air pressure rises above a limit determined by the weight applied to the piston, the piston will rise, resulting in the air (which was under pressure in the pipes referred to) being exhausted. When this pressure is relieved the discharge valves are thrown wide open by the air pressure in the cylinder, and stay wide open, the result being



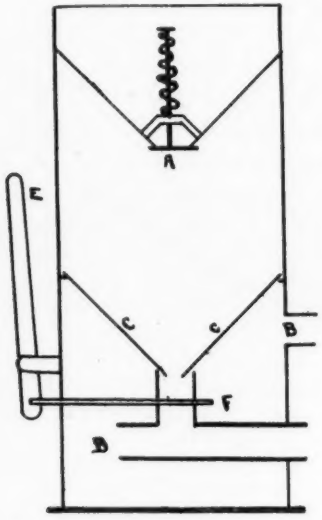
The Air Compressor.

of course, that the inlet valve rings are held shut and the piston has receiver pressure on both sides, and moves back and forth in equilibrium. At the same instant the throttle valve closes to a point which admits just enough of steam to overcome friction and keep the engine moving fast enough to prevent centering. The extent to which the regulator throttle valve closes is regulated by an adjustable nut.

From the air receiver the air was carried by a pipe to the third floor of the building and from thence by a hose to the portable sand blast apparatus.

The sand blast apparatus was built and loaned to the college by Ward and Nash of Boston, Mass.

It consisted of a circular iron receiver a section of which is shown in the sketch.



Sand is fed into it through the valve A while the air goes in at B. The funnel C does not fit tight to the interior of the cylinder so that the air pressure above and below it are the same. The air passes through the end of the pipe D and out through hose to the nozzle and the sand dropping down from the bottom of the funnel is carried with it, By means of the lever E the slider F is pushed in or out and the flow of sand regulated.

The great disadvantage of the apparatus was that the air pressure on A was so great that it could not be opened when the machine was in operation so that the compressor had to be stopped whenever the apparatus had to be recharged with sand. In some of the machines manufactured by Ward and Nash, an air lock is introduced and this difficulty overcome. From the sand blast apparatus the stream of air and sand was carried through a three inch hose to the wall aud discharged upon it through a half inch nozzle.

The velocity of the sand was quite high and the bombardment of the particles cut away the discolored surface in a very rapid and satisfactory manner. The pointing between the stones was cut away but that had nearly all been cracked by the fire and would have had to be done over again at any rate. The sand stone arches and facing around the windows was cut away very rapidly and care had to be taken that the dressed edges were not spoiled.

The sand used was the best sea shore, clean and sharp. It had to be thoroughly dried before using not only to prevent its caking in the machine but to improve its cutting properties. The sand after using was found to be worn quite round and smooth and was of little use for the same purpose again. The consumption of sand however, was very moderate. Four buckets were required to charge the apparatus and this was sufficient to clean several yards of wall surface. Care had to be taken not to feed the sand too rapidly otherwise the apparatus became clogged until the pressure rose high enough to drive out the sand and then it poured out of the nozzle in a thick stream and at such a low velocity as to be useless for cutting purposes

The air pressure used was quite low, a pressure ranging from 12 to 15 lbs. per square inch proving most effective.

J C. HECKMAN, '99.

Tests of a King-Riedler Air Compressor, at the Rose Deep Mine, South Africa.

PAPER READ BY MR. L. I. SEYMOUR, BEFORE THE SOUTH AFRICAN ASSOCIATION OF ENGINEERS AND ARCHITECTS.

ENGINE.

A Vertical King—Riedler Compound Steam and Double Stage Air Compressor at the ROSE DEEP, LTD. No. 1 Shaft.

Diameter of high pressure steam cylinder	19	inches	stroke	41·6875	inches
,, ,, low ,, ,,	30	,,	,,	41·9375	,,
,, ,, 1st stage air cylinder	30	,,	,,	41·9375	,,
,, ,, 2nd ,, ,, ,,	17·5	,,	,,	41·6875	,,
,, ,, piston rods - - - - -				3·46875	feet

The two steam piston rods are connected by a short link to a triangular connecting rod, and the power from them transmitted through a crankshaft, flywheel and another triangular connecting rod and links to the two air cylinders.

The intercooler for the air is placed on the platform by the side of the air cylinders (N.B.—This intercooler was not very effective and is now being fitted with baffle plates, which will reduce the temperature of the air in the intercooler to less than that drawn into the 1st stage cylinder).

The circulating pump for intercooler and water jackets was driven directly by the engine.

The air pump and jet condenser was disconnected.

JACKETS.

The high pressure steam cylinder jacket was under boiler pressure, while the low pressure steam cylinder jacket was reduced to a pressure from 30 to 40 lbs. per square inch by a "Royle" reducing valve. The jackets were drained by a "Kieley" trap, and the discharge weighed.

CONDENSER.

A "Wheeler" independent condenser (capacity 30,000 lbs. of steam per hour) with Admiralty tubes and attached horizontal air and circulating pumps, steam cylinder 16", air pump 16", circulating pump 18" x 24" stroke, was used during this trial entirely for the compressor; although ordinarily it condenses for the compressor, a 12½" and 19" x 42" Cornish pumping plant, a small temporary lighting plant and a pair of 10-1/2" and 17" x 28" horizontal tandem compound "Tangye" winding engine. The steam actuating the motive cylinder exhausted directly into the condenser, and all the steam used was charged against the compressor. The discharge from the condenser air pump was not measured the water pumped into boilers being weighed.

BOILERS.

The two boilers in use were of the horizontal return tubular type, (see annexed sketch).

Diameter of shell in inches - -	66
Length between tube plate in feet -	16
Number of tubes in each boiler - -	104
Outside diameter of tubes in inches -	3
Number of square feet of grate surface	35
,, ,, ,, ,, ,, heating ,,	1500
Ratio of grate to heating surface -	1·428

No economizers were used with these boilers. A separator was fitted on the steam main to compressor and drained by a "Kieley" trap.

The water discharged from this tray was weighed.

COAL.

The coal used was "Clydesdale" having an evaporative value under the conditions of the trial of 5·815 lbs. of water per lb. of coal, (3 of rounds to 1 of nuts).

DRILLS,

31 Ingersoll-Sergeant drills were started at 9.45 a.m., (Mine time), all being set up and ready to start simultaneously. The air pressure at the start was 46 lbs. per square inch and as this could not be raised with the compressor running at about 90 revolutions per minute, two drills were stopped after drilling 8 ft. 2 ins. and 3 ft. respectively, The pressure then gradually

rose 70 lbs. per square inch. Twice afterwards it fell to 48 lbs. and three times rose to 95 lbs. finishing at 80 lbs. (per square inch at 3.45 p.m. the average pressure was 69·83 lbs.)

The size of drills (all Ingersoll-Sergeant).

Two of the 3¼ in. drills ran 2 hours and 1 hour respectively.

This reduces the average time of running of the 32·4 3¼ in. drills from 6 hours (duration on trial) to 5·78 hours, which is equivalent to 30·9 3¼ in. drills running for an average time of 6 hours.

One	2-1/2	inches value compared to 3¼ inches Ingersoll-Sergeant drill	445
Eleven	3-1/4	" " " " " " " " " "	1·000
Seven	3-5/16	" " " " " " " " " "	1·069
Twelve	3-3/8	" " " " " " " " " "	1·123

Total 31 drills, equal in value to 32·4 3¼ inch drills.

Name of Drillman.	No. of Holes.	No of Machines.	Footage.	Remarks.
J Stephens -	7	1	19 feet 7 inches	
D. McAvoy -	2	1	8 " 2 "	stopped after about 2 hours
" -	8	1	36 " 5 "	
R. Wilson -	6	1	29 " 5 "	
G. Tonkin -	9	1	51 " 9 "	4 dry holes
Walters -	2	1	11 " 5 "	
" -	1	1	3 " 0 "	stopped after about 1 hour
T. Mylroie -	8	1	40 " 6 "	
J. C. Mylroie -	4	1	19 " 5 "	
H. Temby -	8	1	48 " 9 "	3 dry holes
R Dellbridge -	9	1	46 " 2 "	3 " "
S Uren -	8	1	44 " 8 "	
T. H. Trevillion	15	2	85 " 11 "	
J H. Harris -	8	2	42 " 4 "	
J. Cock -	9	2	42 " 1 "	4 dry holes
H. Carnow -	7	2	45 " 8 "	
Blain -	10	2	50 " 8 "	4 dry holes
J. Carlson -	6	1	32 " 9 "	
J A. Harris -	9	2	58 " 5 "	
Cock -	8	2	44 " 7 "	
J. Harrison -	8	2	42 " 3 "	
J. Handley -	7	2	35 " 3 "	
Totals	159	31	230 " 2 "	18 dry holes

N. B.—The comparative values of the drills was measured by filling the cylinders ports, etc., with water).

All holes not indicated were wet holes.

A bonus of £5 was given to C. Tonkin for drilling the most footage with his machine.

The footage of 30·0 drills averages 26 ft. $10\frac{2}{5}$ in. per drill in 6 hours which is equal to 4ft. $5\frac{11}{15}$ per drill per hour.

DATA.

Duration of trial in hours	6	
Average height of mercurial barometer in inches (corrected)		24·5
" pressure in lbs. per square inch		12·04
" " " steam by gauge		105·39
" " " " (absolute)		117·43
" vacuum in inches of mercury		21·24
" pressure of air in intercooler		27·0
" " " " receiver		69·83
" temperature of air entering 1st stage air cylinder in degrees Fah	52·0	543·0 abs
" temperature of air leaving 1st stage air cylinder in degrees Fah	292·8	753·8 "
" temperature of air entering 2nd stage of air cylinder in degrees Fah	131·9	592·9
" temperature of air leaving 2nd stage air cylinder in degrees Fah	243·5	704·5
" temperature of air at drills in mines in degrees Fah	65·0	526·0
Percentage of volume taken by 2nd stage air cylinder to that discharged by 1st stage air cylinder		78·65
" of volume taken by 2nd stage air cylinder to that discharged by 1st stage air cylinder, if air had been reduced by proper intercooling to temperature used at drills		69·78
Number of revolutions of engine during trial		29916·0
Average number of revolutions per minute		83·1
" temperature corresponding to absolute steam pressure in degrees Fah		339·37
" temperature of feed water		98·0
B. T. U. in each lb. of the dry steam		1317·45
" " " " " feed water		98·97
" absorbed by each lb. of the feed water		1119·38

Factor of evaporation	1 139
Lbs. of water pumped into boiler	46873·8
„ „ moisture in the steam	422 85
Factor of dryness of the steam	99·16
Lbs. of dry steam used by steam jacket	3071·0
„ „ „ „ „ engine (including indep. condenser)	43380·25
Total lbs. of dry steam used by engine (including steam for jacket and independent condenser)	46451·25
Total lbs. of dry steam used by engine (including steam for jacket and independent condenser) per hour	7741·87
Lbs. of water used by condenser (by meter)	1434500·0
„ „ „ „ „ „ per lb. of steam condensed	33·07
Temperature of water entering condenser in degrees Fah	79·79
„ „ „ leaving „ „ „ „	106 45
B. T. U. in each lb. of water entering condenser	79·85
„ absorbed by each lb. of the circulating water	26 71

RESULTS.

I.H.P. of steam cylinders	373·65
„ „ air and circulating pump	19·51
Total I.H.P. of engine	393·16
I H·P· of air cylinders	338·77
Mechanical efficiency of engine per cent.	86 17
„ „ „ „ (without including air and circulating pumps) per cent.	90·66
Lbs. of dry steam used by engine and independent condenser per I.H.P. per hour	18·39
Lbs of dry steam used by jacket per I.H.P. per hour	1·30
Total lbs. dry steam used per I.H P. per hour	19·69
Lbs. of coal used per I H.P. per hour (assuming 1 lb. of coal will evaporate 6·74 lbs. of water from and at 212° Fah cost of coal 13/9 per 2000 lbs.)	3·38
Cost of coal per I.H.P. per hour in pence	0·28
Heat efficiency of engine per cent.	10·7
Average volume of free air entering 1st stage cylinder in cubic feet per minute	2505·5
„ volume of air leaving 2nd stage cylinder at 69·83 lbs. gauge pressure and at the temperature used at drills (65° Fah) in cubic feet per minute	368·46
I.H.P. at compressor steam cylinder per 3¼ in. drill	12·72
Cubic feet of free air required per 3¼ in. drill per minute including all leakages	81·08
Lbs. of coal required per drill per hour	42·99
Cost of coal per drill per hour in pence	3·55

SUMMARY OF MAIN DETAILS.

Diameter of high pressure steam cylinder 19 inch stroke	41·6875	
„ „ low „ „ „ 30 „ „	41·9375	
„ „ 1st stage air cylinder 30 „ „	41 9375	
„ „ 2nd „ „ „ 17 5 „ „	41·6875	
Average revolutions per minute	83·1	
„ steam pressure (by gauge)	105·39	
„ vacuum (by gauge)	21·24	ins.
„ intercooler air pressure (by gauge)	27·0	
„ receiver „ „ „ „	69 83	
„ temperature of air entering 1st stage cylinder in degrees Fah	82·0	(543 abs)
„ temperature of air at drills in degrees Fah	65.0	(526 abs)
Actual number of 3¼ inch drills working	30·9	
Duration of trial in hours	6.0	
Total footage of holes drilled	830 ft. 3 inches	
Average „ „ „ „ per machine	26 „ 10-2/5 inches	
Cubic feet of free air compressed per minute	2505·5	
„ „ „ air at drills per minute at 69·83 lbs. pressure and 65° Fah	368·46	
„ „ „ free air used per 3¼ inch drill per minute	81·08	
„ „ „ air used per drill per minute at 69·83 lbs pressure and 65° Fah	11·92	
Average I.H.P. of steam cylinders (including air and circulating pump)	393·16	
„ I.H P. of air cylinders	338 77	
Mechanical efficiency per cent.	86 17	
Average steam I H.P. per drill	12·72	
„ feed water to boilers per I.H.P. per hour	19.69	
„ cost of coal per drill per hour in pence	3·56	

Tested February 16th, 1898.

I believe the footage of drilled during these six hours actual work is equal to the average work done per shift of drilling, which is usually of eight hours duration; on account of the drills being all set up ready to work and also the incentive, etc.

In other words I do not think the compressor would have made many more revolutions during eight hours ordinary working, than it did during the six hours trial. If this be true then the average steam horse power per drill would be reduced by 12·72-×6÷8=9·54 or the probable steam horse power actually required per drill.

It must be borne in mind that this machine was specially designed for a high speed, with large valves having a high lift.

In addition to this, the air pipes at the Rose Deep, are remarkably free from leaks. Against this, the drill pistons are made a good fit in their cylinders and no packing rings are used.

Were the compressor only charged with its *pro rata* of the power required by the air and circulating pumps, as ordinarily used, the result would have been better.

Three other trials have been made since, which demonstrate that the total steam used per indicated horse power is 1·2 lbs. less, where the jackets are *not* used, than has been obtained on this trial.

I should not like to state this as being true under all conditions, inasmuch as the steam at the compressor is very dry, and were it moderately wet, no doubt the performance with jackets would be better than without.

Two boilers easily ran the compressor, and during a later trial which was non-condensing, the same two boilers ran the compressor but with hard firing.

The steam used in this latter trial was 25·75 lbs. per indicated horse power, over 31 per cent. more than when condensing.

The lbs. water evaporated into steam per boiler per hour was 3871 equal to 2·58 lbs. per square foot, heating surface, while on the non-condensing trial this was nearly 3·35 lbs. water evaporated per square foot per hour.

The cubic feet of free air compressed per minute was calculated from the first stage air cylinder card, the points at which the compression and re expansion lines across the atmosphere, being taken as the volume of air actually delivered, which was 88·4 per cent. of the theoretical cylinder volume.

The compressor had been in constant use for three years, with few repairs, the only alterations being to substitute forged steel connecting rods in place of the original cast steel ones, which had proved defective.

The fluctuations in the air pressure were on account of the governor being disconnected and the speed regulated by hand.

The latter type of intercoolers supplied with these machines, in which the air is made to cross the cooling tubes three times instead of moving lengthwise, is a decided improvement and adds materially to the economy by reducing the volume of air discharged by the first stage cylinder and compressed by the second stage from 78·65 to 69·78 per cent.

Having proved that with this compressor running at a high rate of speed we compress 382·3 cubic feet of free air at 12 lbs. atm. pressure to a pressure of 69·83 lbs. per square inch, per steam indicated horse power per hour. I reserve for a future discussion and paper, the amount of air necessary under conditions existing on these fields, to again generate one brake horse power and I trust by this means we may obtain some reliable data of the efficiency of transmission of power by compresed air, for comparison with other methods more in use.

Practical Application of High Range Compressed Air Power Transmission.*

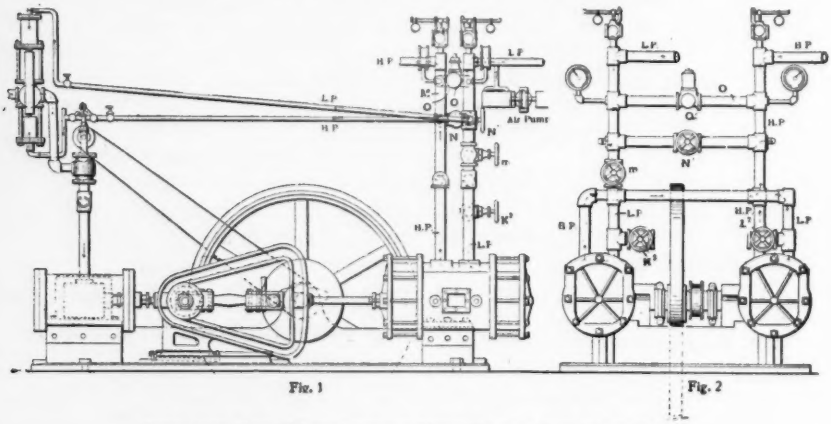
BY FRANK RICHARDS.

I use the term high range to designate the system here referred to for convenience as it seems to fit the case, whether it has been used before or not. The system is called also the two-pipe system, on account of the return pipe, made necessary to convey the air which has done its work back to the compressor, the exhaust pressure being constantly maintained very much higher than that of the atmosphere. The system has been put into practical operation in California and elsewhere in the far western portion of the United States, being known there as the Cummings system of compressed air transmission, the apparatus there employed being under United States patents granted to Charles Cummings, of Oakland, Cal.

* *American Machinist.*

Under this system the compressor in full operation receives the air returning from rock-drills, pumps, hoists, motors, or whatever it is employed to drive, at a pressure considerably above that of the atmosphere, compresses it to a still higher pressure, and then sends it out again to do more work. The operation as thus stated is as simple as that of the ordinary air compressor, which takes in free air, or air at atmospheric pressure, and sends it out again at a pressure of, say, six or seven atmospheres. In compressing from one to seven atmospheres or in compressing from seven to 14 atmospheres there is no essential difference in the operation involved.

If the compressor is to work at anything like the pressures last indicated there must however, be some provision for first charging the system to the high initial pressure required, and also some means of governing or controlling the speed and output of the compressor according to the rate at which the air may be used at the other end of the system. The arrangements by which these results are accomplished are worth looking into. Fig. 1 is a side elevation, Fig. 2 is an end elevation and Fig. 3 a plan of a duplex steam driven compressor. Of the general design of the compressor it is not necessary to speak. It will scarcely be maintained that it represents the best possible arrangement. The steam cylinders are at the left, Fig. 1, and the pull and thrust of the steam piston is transmitted directly through the yoke in which the connecting rod plays to the air cylinder. The body of the air cylinder is water jacketed and the valve chambers on each end have each a vertical partition, the inlet valves and pipes being on one side and the discharge valves and pipes on the other. The air being at normal atmospheric pressure throughout the apparatus we may start the compressor, referring principally to Fig. 2, and as we proceed the functions of the pipes and connections will reveal themselves. Both compressing cylinders are alike in construction and operation. At the beginning of operations we may assume the globe valve M to be closed and all other valves to be open. The free air will enter through valves K^2 and L^2 and the compression will continue until the pressure rises to, say, 100 pounds, if we assume that pressure for the lower limit of our working range. When the pressure of 100 pounds is reached valve N^1 is closed by hand, separating the high pressure and the low pressure pipes, and the operation of compression then continues until the high pressure pipes are filled to the high pressure required, say 200 pounds, while the low pressure system remains charged at 100 pounds. The air inlet valves K^2 and L^2 are closed by hand and valve M is opened, allowing the 100 pound air to be delivered to both cylinders. The entire apparatus is now a closed system, with both the high and the low pressures as required, and ready for continuous action. A small pump U, shown in Fig. 1 up at the right, replaces what air may be lost by leakage. This pump may be placed



SIDE AND END ELEVATION OF HIGH RANGE AIR COMPRESSOR.

wherever most convenient and may be operated by connection with the main compressor or otherwise, and here requires no further mention.

Attention is now called to cross pipe *O*. This pipe directly connects the high pressure and the low pressure pipes. Somewhere between the two pipes is located the valve *O'*. This is an adjustable pressure

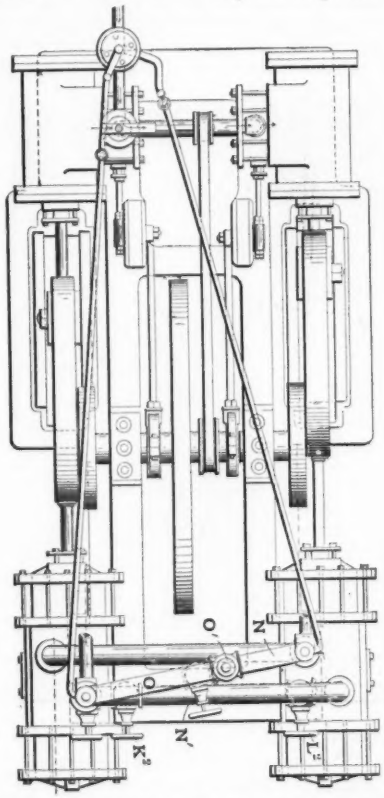


FIG. 3.—PLAN OF HIGH RANGE AIR COMPRESSOS.

valve which may be set to open at any pre-determined difference of pressure, in this case 100 pounds, and it will not open until that difference exists, when any excess of air in the high pressure pipes is automatically discharged into the low pressure, thus constantly maintaining the required difference. The compressor may be charged or put in condition for continuous operation by the use of this automatic valve instead of by the hand operated valve *N'*.

The operation of governing an air compressor, either under the system we are considering or any other, is distinctly different from that of governing a stationary steam engine. The amount of power required may fluctuate in either case, but in that of the steam engine it is still usually necessary to maintain a constant rate of speed. In the case of the air compressor it is necessary to vary the speed according to the work. With our closed circuit of piping, and assuming the compressor at one end and the motor at the other, each running at such relative speeds that the difference of 100 pounds is just maintained between the two pipes, if it should then happen that the motor should be run slower, or in anyway should require less air to pass through it, then if the compressor still maintained its speed, the pressure in the high pressure pipes would become too great, while in the low pressure pipes the pressure would fall too low. The reverse operation would result as badly in the opposite direction. A centrifugal governor is provided, as shown, to control the speed of the compressor when the demand upon it is up to its full capacity and prevent it from running away. This governor may also come into play in the earlier stages of the initial charging of the system, but is of no use at other times, the differential pressure governor being the usually operative controlling device. This governor, which it is scarcely necessary to describe in detail, is indicated in outline up at the left of Fig. 1. It consists of two cylinders of different areas, say one twice that of the other, the two pistons being connected and moving together and by their movement operating a sliding steam valve and controlling the flow of steam to the steam cylinder. These governor cylinders standing vertical, and that of the larger area being above, with the smaller cylinder below, a small pipe connecting with the low pressure system is led into the top of the large cylinder, while a pipe from the high pressure system enters the bottom of the lower and smaller cylinder. The differences in pressures being compensated by the differences of piston areas, the piston and the steam valve are stationary when the difference in pressures is normal, while if the high pressure increases the steam valves closes and slows the compressor. and if the high pressure falls while the low pressure increases then the steam valves moves in the other direction, more steam is admitted and the compressor runs faster.

The compressor being duplex, with cranks at right angles, it will of course start itself from any position. The compressor for this system, it will thus be seen, requires little complication above that of the ordinary compressor.

It is proper to say a little as to the actual practical workings of the system. As is well known, the use of compressed air is perhaps better developed and better appreciated upon the Pacific coast than anywhere else in the United States. Some admirable installations of the ordinary type are in operation there and some notable instances of large plants and long distance transmission. It is not strange that the two pipe system also should find its first employment in the same section. It can scarcely be claimed for it that its possibilities have yet been all developed or that its applications have been other than crude and cheap. The half-tone herewith speaks for itself as to the conditions under which it has been tried (or it would have so spoken if the engraver had not taken such pains to make the scene respectable). The compressor here shown is of different construction from that which I have described, but it embodies the same two pipe principal. As to the results attained, there are not as yet any thorough, careful and precise tests to be referred to, and we must be content with statements such as the following:

"Two tests were made of three hours each, one with the machinery run under the two pipe system, and the other with the same machinery run under the ordinary system. In each one the same machinery was used throughout. This consisted of a duplex air compressor with air cylinder 5x9 inches, and steam cylinder 6½x9 inches, and a water pump with air cylinder 4½x7 inches, and water cylinder 5x7 inches." These dimensions are not altogether clear and satisfactory, but I give them as I have received them. The statement of comparative performance which follows is more intelligible.

"The machinery was run for three hours under the two-pipe, high range system. One of the pipes was then disconnected and the same machinery was run under the ordinary system. That is to say, instead of exhausting into the return pipe, the exhausting was done

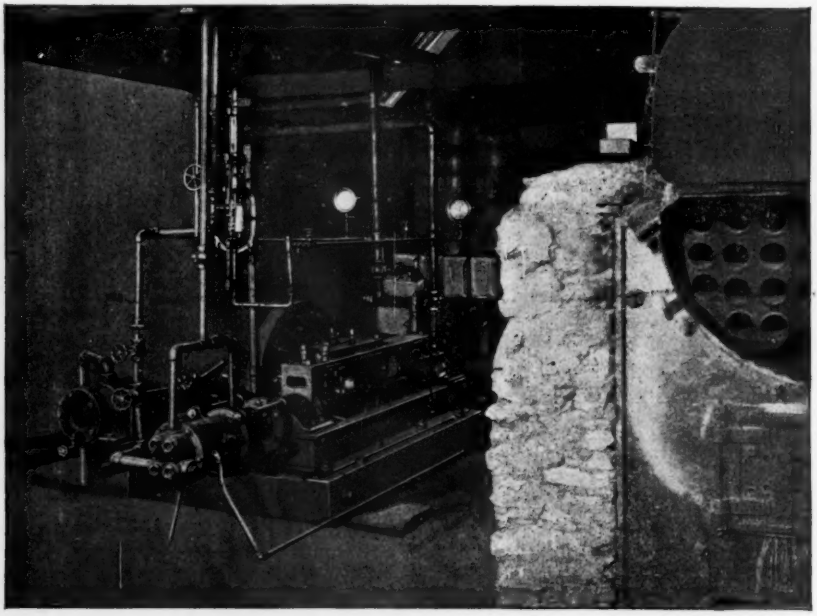


FIG. 4.—HIGH RANGE AIR COMPRESSOR IN SERVICE.

into the atmosphere. The pump was employed in elevating water 80 feet. The first three hours under the two-pipe system the pump made 23,877 revolutions while the compressor made 16,735 revolutions. In the second three hours, running under the ordinary system, the compressor made 22,735 revolutions and the pump 5,380." There was, of course, no such advantage as the figures given seem to indicate, but that there was a great advantage seems clear. "In the two-pipe system we ran the pump about as fast as is consistent with good practice, while the compressor had to be run comparatively slow. In the ordinary system we could hardly run the compressor fast enough to give sufficient air to the pump to turn over. We had great difficulty in running three hours under the ordinary system, owing to the fact that the temperature in the exhaust ports of the pump came below the freezing point of water. We had to use petroleum to make the pump work. Of course, under the two-pipe system there is no chance of any ice being formed from the expansion of the air."

Hans C. Behr, in a bulletin of the California Mining Bureau, says: "The incidental advantage in the two-pipe system is that the pump engines, particularly if direct acting, can be operated under water until they wear out." He says also: "To properly estimate the value of this system it must be compared to the reheating system as to mechanical efficiency, first cost and simplicity of construction and manipulation." I have seen also enough other letters to probably convince any ordinary person that this system gives quite astonishing results.

Pneumatic Tools.

The pneumatic tool people are always enthusiastic, always practical and always on the ground with appliances that meet demands of supreme interest to the trade. What is the concern of one is the concern of all in that line, and wherever we go we find several makes of machines doing good work, and apparently producing profit for the makers.

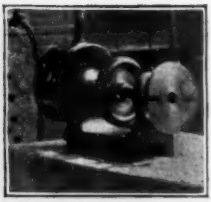
A catalogue came to us recently that elicited the admiration of our Art Editor

MR. J. W. DUNTLEY, PRESIDENT, CHICAGO PNEUMATIC TOOL CO.

to an unusual extent, and when he casts his eye over any literary production you can rely upon his judgment and expert criticism. For the benefit of those who make catalogues it should be said that certain elements enter into the make-up of a catalogue that either put the stamp of life

MR. ALDCORN, THE NEW YORK MANAGER.

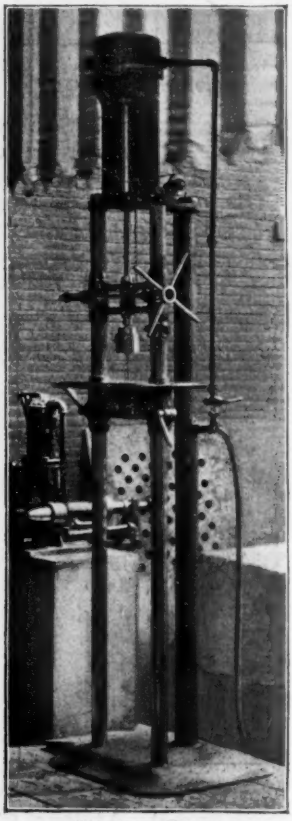
or of inaction upon it. A thing of this sort may be very pretty, femininely pretty,



MOTOR ATTACHED TO LATHE.

delicate, but weak. Again it may be pretty, physically pretty, every line distinct, but strong. The catalogue we speak of, issued by the Chicago Pneumatic Tool Co., Chicago and New York, combines the requirements mentioned in the latter description, and from the two we always select that.

A detail of the contents of the catalogue shows fine illustrations of the various tools manufactured by them, reproduced from life models on actual work. Views are shown in boiler works, ship-building yards, architectural iron works, machine shops, etc., and in support of the claims made as to durability and efficiency numerous letters from well-known superintendents, presidents and other officers of works, are printed in short and attractive form. The catalogue is rich and substantial; the one coming to us bound in fine morocco leather which insures our keeping it always in legible condition.

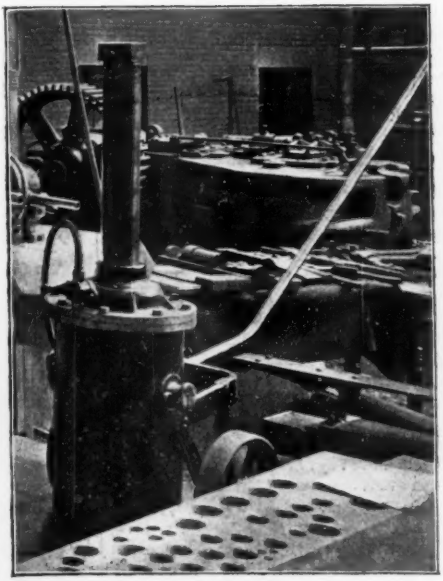


VERTICAL DRILL.

CHIPPING TOOL.

As a reference it is valuable. It shows where and how the tools may be used. One particularly striking picture represents a man chipping the screw of a boat the keel of which is located in the last abode of our old friend McGinty.

We herewith present some sketches of the exhibit of this company at the M. M.



PORTABLE PNEUMATIC JACK.

& M. C. B. Convention at Saratoga, held in June last, which simply goes to show the widespreading activity of the firm whether in Chicago, Saratoga, New York, Boston or elsewhere, and whether through the instrumentality of a catalogue or by the personnel of the company itself, it makes an impression that must be lasting and have good results. For further particulars as to the line of goods and how they look or may be applied, we refer you to the catalogue.

The Chicago Pneumatic Tool Company, Chicago and New York, report a gratifying business during the dull summer season. Mail orders for one day, Monday, July 25, aggregated 78 pneumatic machines covering a variety of appliances, as follows;

44 Pneumatic Hammers.
8 Pneumatic Holders on.
6 Rivitting Machines,
4 Boyer Drills.
12 Breast Drills for wood boring.
2 Air Hoists.
2 Flue Welders.

Four machines go to the Imperial Chinese Railway.

PATENTS GRANTED JUNE, 1898.

Specially prepared for COMPRESSED AIR from the Patent Office files by Grafton L. McGill, Washington, D. C.

605,394—Air-Brake. W. H. Clowry, Chicago, Ill.

The car-body and truck are provided with the customary braking mechanism. An auxiliary brake-cylinder has its piston connected with the braking mechanism, while a valve, operated by a fluid motor, controls the connection between the said auxiliary cylinder and the train-pipe. The variations in the height of the car-body actuate the controlling valve that is, a normal depression of the car-body will open the controlling valve, while an abnormal depression of the car-body will cut-out the said auxiliary brake-cylinder.

605,329—Hot-Air Furnace Thos. G. Neal, Warren, Pa.

The furnace consists of an outer casting and an inner heating drum. A plurality of vertically-disposed radiators encircle the drum and each other, deflectors being arranged between the radiators Outlets connect, respectively, the heating drum with the adjacent radiators and the radiators with each other, while a separate outlet connects the outermost radiator with the chimney. These outlets being located in the lower portions of the radiators, provide an indirect circulation of the products of combustion.

605,904—Air-Brake. H. S. Park, Chicago, Ill. Assignor to The Westinghouse Air-Brake Co., Pittsburgh, Pa.

This invention consists of a triple-valve device and a train-pipe release-valve for releasing fluid under pressure to the atmosphere. A supplemental piston is adapted to open the release valve, which is normally exposed on its opposite sides to fluid under pressure The valve is held closed by a spring, while means are provided for equalizing the pressures on opposite sides of the supplemental piston. Thus the spring closes the valve automatically when a limited quantity of fluid has been released from the train-pipe, that is, when the pressure of the train-pipe has been reduced sufficiently to effect a full application of the brakes.

605,905—Air-Brake H. S Park, Chicago, Ill. Assignor to The Westinghouse Air-Brake Co., Pittsburgh, Pa.

A chamber communicates with the train-pipe and with the main-valve chamber, the latter having a piston therein carrying a slide-valve provided with a passage. This slide-valve controls a port in the valve-casing communicating with the brake-cylinder. Two passages lead from the main-valve chamber in front of its piston, one to a vent-chamber, and the other to the main-valve chamber back of the piston. The vent-chamber contains a piston normally exposed to air under pressure. The piston carries a valve which controls vent-opening, while a separate passage connects the vent-chamber with that of the train-pipe.

605,876—Pneumatic Motor. F. W. Hedgeland, Chicago, Ill. Assignor to The W. W. Kimball Co., same place.

A series of valves correspond to, and control, the inflating and deflating of a plurality of pneumatics. Motors control the valves, and are themselves controlled by a single rotating valve.

ALPHABETICAL LIST OF PNEUMATIC INVENTIONS

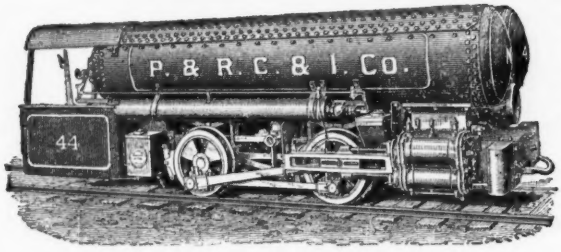
For which United States patents have been granted. Prepared for COMPRESSED AIR from official records by GRAFTON L. McGILL.

APPLIANCE.	NAME OF INVENTOR.	DATE OF ISSUE.	No.
Air Compressor	Allen	May 27, 1884	299,314
"	Babcock	July 10, 1883	280,997
"	Babcock	Oct. 23, 1883	287,358
"	Bennett	Aug. 28, 1883	283,955
"	Bicknell	Feb. 27, 1883	273,014
"	Bolton	March 24, 1885	314,218
"	Brislin	Aug. 5, 1884	302,978
"	Chamberlain	Jan. 10, 1888	376,141
"	Chichester	Jan. 12, 1886	333,994
"	Chichester	Sept. 27, 1887	370,376
"	Chichester	Nov. 18, 1884	308,061
"	Corey	Jan. 20, 1885	311,106
"	Cullen	Nov. 4, 1884	307,442
"	Cullingworth	Feb. 7, 1888	377,481
"	Cullingworth	Oct. 23, 1883	287,104
"	Cullingworth	Dec. 28, 1886	355,002
"	Cummings	May 24, 1887	363,509
"	Dean	March 27, 1888	380,195
"	Depp	Jan. 5, 1886	333,613
"	Dow	May 4, 1886	341,099
"	Ehlers	July 1, 1884	301,348
"	Erwin	April 20, 1886	340,496
"	Erwin	May 15, 1888	382,760
"	Erwin	Oct. 27, 1885	329,377
"	Erwin	Dec. 29, 1885	333,208
"	Fevrot	Feb. 16, 1886	336,224
"	Fox	June 30, 1885	321,206
"	"	June 30, 1885	321,207
"	Fox	Sept. 25, 1883	285,743
"	Forster	Jan. 3, 1888	375,929
"	"	Jan. 17, 1888	376,589
"	"	June 12, 1888	384,356
"	Freeman	Dec. 25, 1883	290,764
"	Harrold	July 20, 1886	345,969
"	Hill	Feb. 5, 1884	292,814
"	Honigmann	Nov. 13, 1883	288,435
"	Hugentobler	June 1, 1886	342,798
"	Hunter	Nov. 13, 1888	392,611
"	Johnson	Sept. 21, 1886	349,954
"	Keenan	June 12, 1888	384,529
"	Krutsch	July 15, 1884	302,206
"	Lawler	Feb 20, 1883	272,711
"	Leavitt	June 23, 1885	320,482
"	Manz	May 2, 1876	176,795
"	Mayrhofer	July 25, 1882	261,560
"	"	Jan. 18, 1881	236,713
"	McKim	Jan. 3, 1888	375,761
"	McLean	May 11, 1886	341,673
"	Middleton	Sept. 22, 1874	155,328
"	Monson	May 16, 1882	257,885
"	Moore	June 3, 1879	216,211

Established 1831. **Annual Capacity 1,000.**

BALDWIN LOCOMOTIVE WORKS,

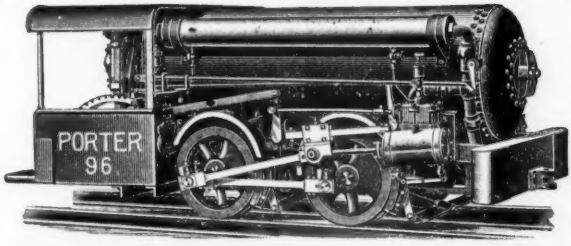
Single Expansion and Compound Compressed Air Locomotives,



Adapted to every variety of service, and built accurately to gauges and templates after standard designs.
Like parts of different engines of same class perfectly interchangeable.

BURNHAM, WILLIAMS & CO.,

PHILADELPHIA, PA., U. S. A.



Compressed Air Mine Haulage.

Safe from fire, handier, more reliable and more economical in installation and operation than other systems; adopted by representative anthracite and bituminous collieries after exhaustive examination. On *bona fide* request of mine owner or superintendents, or other prospective buyer, we will mail free our 8th Edition, 216 page catalogue, of steam, electric and pneumatic locomotives. To accommodate correspondents not in the market for locomotives, a copy will be mailed on receipt of 50 cents in stamps.

Address mentioning "COMPRESSED AIR."

H. K. PORTER & CO., 540 Wood St., Pittsburgh, Pa.

Lubrication .. Oil Pump.

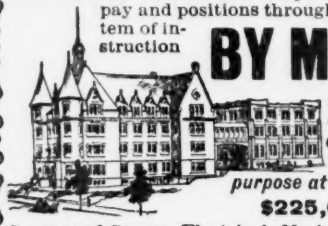
Used for lubricating Air and Steam Cylinders, and Main Bearings of Shafts on large Hoisting Engines, prevents them from getting hot. When engine stops, cup stops feeding.

McCanna Bros.
57 Wells St.,
Chicago, Ill.

EDUCATION

Thousands have been helped to better pay and positions through our system of instruction

BY MAIL



Buildings erected expressly for this purpose at a cost of **$225,000.**

Courses of Steam, Electrical, Mechanical or Civil Engineering; Chemistry; Mining; Mechanical and Architectural Drawing; Surveying; Plumbing; Architecture; Metal Pattern-Drafting; Prospecting; Bookkeeping; Shorthand; English Branches,

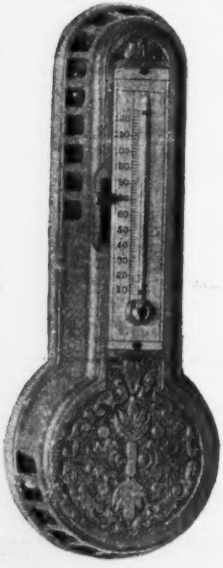
$2 a Month pays for a College Education at Home. 45,000 Students and Graduates.

Circular Free. State subject you wish to study.

The International Correspondence Schools,
Box 1132. SCRANTON, PA.

THE DAVIS & ROESCH,

THERMOSTAT.



TEMPERATURE CONTROLLING SYSTEM

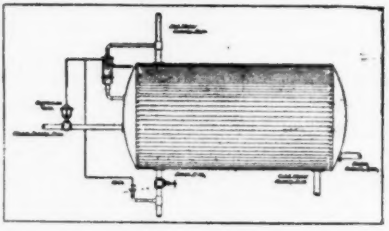
Do you desire an even temperature in your house and office?
Do you consider an even temperature conducive to health and comfort?
Do you find an even temperature difficult to maintain?
Do you think your fuel bills are too high?
Do you consider economy of health and wealth wise?

We assume there can be but one intelligent answer to these queries, and would suggest an investigation of our system as a means of attaining these most desirable ends.

HOT WATER REGULATOR.

Attach it to your hot water tank and it will save *you* fuel and your *engineer* trouble.

It assures a regular and even supply of hot water, and by preventing overheating avoids all possibility of the straining of water pipes or faucets, and the cracking of basins or tubs.



The Davis & Roesch Temperature Controlling Co.,

Treasurer's Office, Havemeyer Bldg., 26 Cortlandt St., New York.
Factory, Bridgeport, Conn.

NEW YORK OFFICE:

122 LIBERTY STREET, ROOMS. 1005-1006, NEW YORK.

MANUFACTURERS OF

PNEUMATIC HAMMERS
PISTON AIR DRILLS
PNEUMATIC RIVETERS
CASTING CLEANERS
AIR HOISTS

All Machines guaranteed against repairs for one year.

Sent on 10 days trial subject to approval.

OVER 2,000 IN USE IN THE UNITED STATES.
OVER 800 IN EUROPE.

REFERENCES FURNISHED UPON REQUEST.

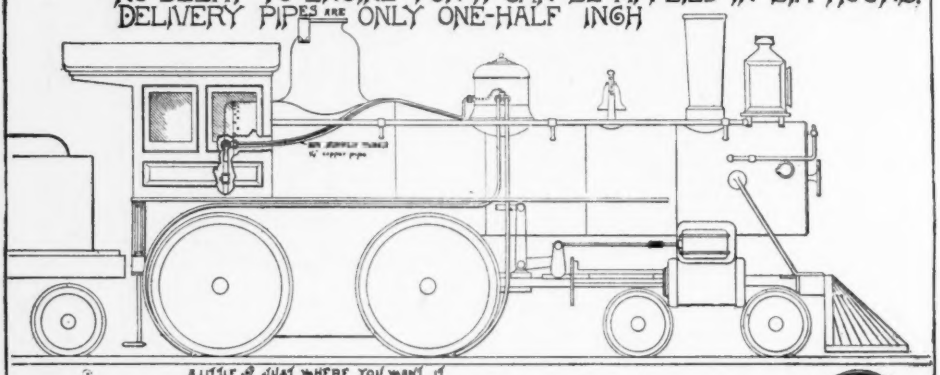
TRIAL ORDERS SOLICITED.

Chicago Pneumatic Tool Co.,

635 MONADNOCK BLOCK · CHICAGO, ILL.

HOUSTON'S PNEUMATIC TRACK SANDER.

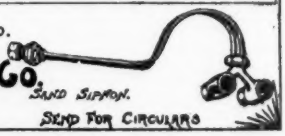
SIPHONS & EJECTS SAND FROM BOX TO RAIL.
APPLIES SAND TO BOTH FRONT & BACK DRIVERS FROM ONE BOX.
NO DELAY TO ENGINE FOR IT CAN BE APPLIED IN SIX HOURS.
DELIVERY PIPES ARE ONLY ONE-HALF INCH



A LITTLE & JUST WHERE YOU WANT IT
& NO POWER LOST IN PULLING TRAIN OVER SUPERFLUOUS SAND.

ENGINEERS VALVE.

WESTERN RAILWAY EQUIPMENT CO.
ST. LOUIS MO.



SAND SIPHON.

SEND FOR CIRCULARS

THE
ENGINEERING MAGAZINE
AN INDUSTRIAL REVIEW

The Engineering Magazine has been aptly described as "*The Century* of the industrial world and the *Review of Reviews* to engineering literature—the two in one." Its leading articles treat the subjects uppermost in importance in industrial affairs. Its contributors include the foremost men of our times. It gives each month an exhaustive Review and Index to the world-wide range of technical literature—American, English, French, and German. It is read in every nook and corner of the civilized world. It is founded upon the idea of meeting the requirements of the busy and brainy men who manage, think, and plan for the engineering, architectural, electrical, railroad, mining, and mechanical industries. It has a larger bona-fide circulation among such men than has ever been attained by an engineering journal in all the history of industrial literature. It is priceless to the active man who needs to keep in touch with current developments. Its every page carries a living interest for intelligent readers who are in any way concerned with modern industrial enterprises. Its subscribers are its warmest advocates and the Magazine itself is its best solicitor. *Sample copy free.*

30 Cents a Number; $3.00 a Year.

THE ENGINEERING MAGAZINE,
120-122 Liberty St., New-York, U. S. A.

Compressed Air.

Practical information upon Air-Compression and the Transmission and Application of Compressed Air.

By FRANK RICHARDS. 12mo, cloth, $1.50

John Wiley & Sons, New York.

READ "ELECTRICITY,"

The Only Independent Electrical Journal
PUBLISHED IN THE UNITED STATES.
All the Electrical and Financial News.
Latest Technical Articles by Home and Foreign Writers.
☞ **THE BEST ADVERTISING MEDIUM.**
Published Weekly. Subscription $2.50 per year.
Address: **ELECTRICITY NEWSAAPER CO.,**
136 Liberty St., New York.

Patents, Trade Marks, Designs.

Searches as to Novelty; Reports on Infringements; Patent Matters Exclusively; 15 years Experience. Refers to Publishers this Magazine. FRANKLAND JANNUS, Attorney-at-Law, Havemeyer Building, 26 Cortlandt St., New York City.—Office in Washington, Atlantic Building.
Always have Title Examined before Investing in Patent Property.

Do You Roast Your Ores?

. . . . YOU CAN SAVE . . . .

FUEL, COST OF REPAIRS AND LABOR,

BY USING

The Ropp Straight Line Furnace,

FOR SALE BY

PARKE & LACY CO.,

21 & 23 Fremont Street, San Francisco, Cal.

SOLE LICENSEES. CATALOGUE UPON APPLICATION.

THE "NASON" AIR-HOIST

. . CYLINDERS . .

For use in conjunction with Compressed Air.

Made in sizes of from 2 in. to 8 in. inside diameter, with lift of hoist from two to ten feet.

CONTRACTORS FOR

The Installation of Pneumatic Hoisting Apparatus.

. . . SAFE, SIMPLE AND RELIABLE . . .

Correspondence Solicited.

NASON MANUFACTURING CO.,

71 BEEKMAN STREET, NEW YORK.

COMPRESSED AIR

THE PULSOMETER STEAM PUMP

"The Contractor's Friend."

OFTEN IMITATED—NEVER EQUALED.
OVER 20,000 IN USE.

Recent Important Improvements.

The Handiest, Simplest and Most Efficient Steam Pump for General Low Service Mining, Quarrying, Railroad, Irrigating, Drainage, Coal-washing, Tank-filling, Paper Mill, Sewer and Bridge Contractors' Purposes, etc., etc.

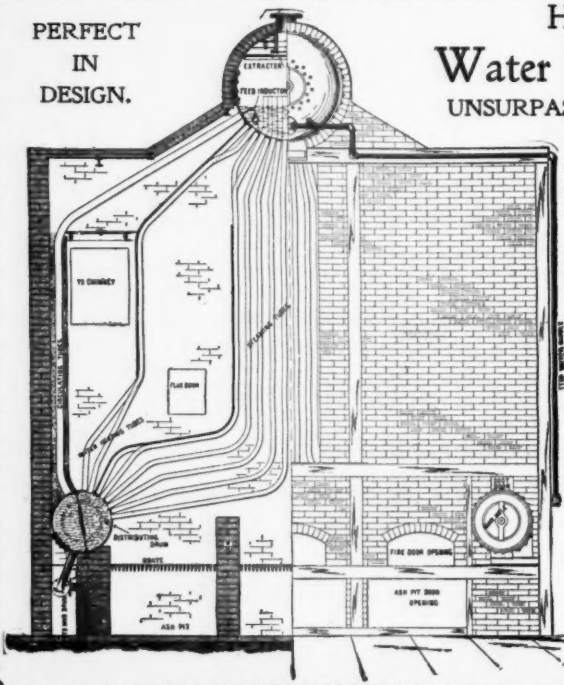
Muddy or gritty liquids handled without injury to the Pump.

PULSOMETER STEAM PUMP CO.

Catalogue on Application. **Correspondence Solicited.**

135 GREENWICH STREET, NEW YORK.

PERFECT IN DESIGN.



HOGAN

Water Tube Boilers,

UNSURPASSED IN ECONOMY.

Always give entire satisfaction. Combines every desirable feature in boiler construction and design.

Safe, Efficient, Durable, Free from Scale on heating surface. Has **positive and continuous circulation.** Need no feed water heaters or steam separators.

Delivers all steam above the water line.

The Water Line is Steadier than can be found **in any other Water Tube Boiler.**

Manufactured by

HOGAN BOILER COMPANY

Middletown, N. Y

— ON ADMIRALTY AND WAR OFFICE LISTS.—

THE MANNESMANN TUBE Co. Ltd.

LANDORE R.S.O. SOUTH WALES.

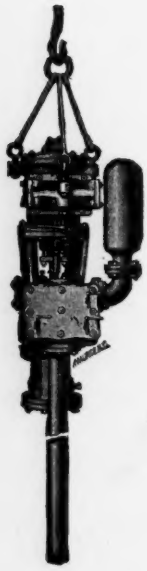
D. B. McILWAINE,

SOLE AGENT FOR AMERICA,

NEW YORK OFFICE:

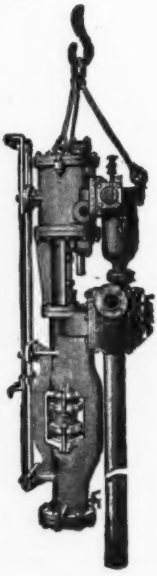
122 Chambers Street, New York.

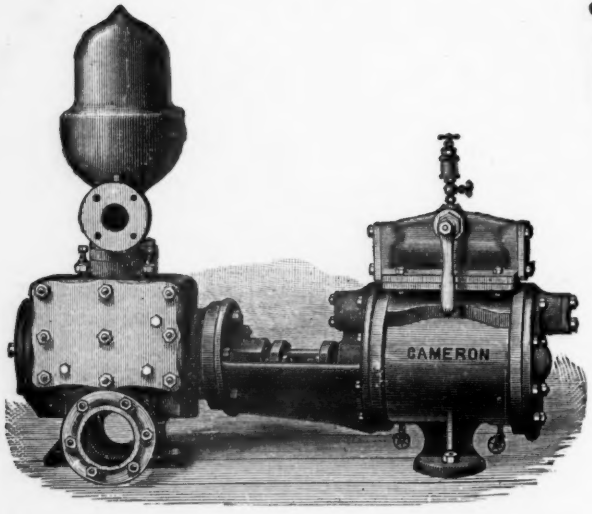
CAMERON STEAM PUMPS.



Simple,
Compact,
Durable,
Efficient.

NO OUTSIDE VALVE GEAR.





ADAPTED TO EVERY POSSIBLE DUTY.

MANUFACTURED BY

THE A. S. CAMERON STEAM PUMP WORKS,

Foot East 23d Street, New York.

THE SECOND VOLUME OF

"COMPRESSED AIR"

March 1897—February, 1898 inclusive,

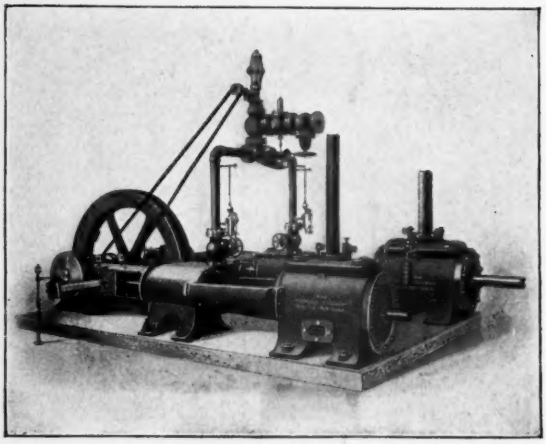
is now ready.

The twelve numbers of "Compressed Air," which make up this volume are profusely illustrated with fine half-tone engravings and line cuts of a large number of important applications of compressed air. The articles contained in the above have been widely quoted, and treat upon a varied collection of air power subjects.

This volume is valuable for those who contemplate the use of compressed air, and are investigating its advantages. Substantially bound in cloth, $2.00.

COMPRESSED AIR,

26 Cortlandt Street, New York.



Send for Booklet 137.
It shows 12 different types of

Air Compressors,

and many names of users, covering a wide range of applications.

USED BY

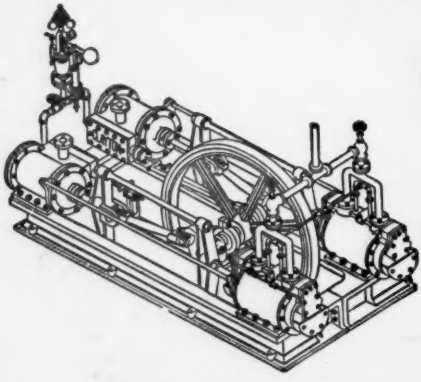
Asbury Park Water Works, Newport News Shipbuilding Co., Erie R. R., P C. C. & St. L and many others.

Class "G" Duplex.

THE Ingersoll-Sergeant Drill Co., HAVEMEYER BUILDING, N. Y.

CLAYTON AIR COMPRESSORS

FOR OPERATING PNEUMATIC SHOP TOOLS, HOISTS, ETC., AIR LIFT PUMPING



AND EVERY OTHER PURPOSE TO WHICH COMPRESSED AIR CAN BE APPLIED.

CLAYTON AIR COMPRESSOR WORKS

CATALOGUE. 26 CORTLANDT STREET, NEW YORK